BARRICK RESOURCES (USA), INC.

MERCUR MINE

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DUMP LEACH No.3
DESIGN DOCUMENT

SUBMITTED TO:

UTAH BUREAU OF WATER POLLUTION CONTROL

FEBRUARY 1990

BARRICK RESOURCES (USA), INC.
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P.O. BOX 838
TOOELE, UTAH 84074

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February, 1990

Barrick Mercur Gold Mine
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Dump Leach 3
Design Document

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Chapter I.

Introduction

Dump leach facilities have become an integral part of operations at the Barrick Mercur Gold Mine. Two dumps already have been constructed on lined foundations. Dump Leach 1 is being decommissioned prior to final reclamation. Dump Leach 2 will continue in operation through October 1990.

Dump Leach 3 is proposed for construction during 1990, with its commissioning in the autumn. This document presents the salient design, construction, and operational features of the dump leach.

Dump Leach 3 has been designed using the experience gained on the first two facilities. In addition, best available technology has been incorporated. This is in the form of textured high density polyethylene (HDPE). An experimental field test was performed to verify the utility of the textured HDPE on the 3:1 slopes of the proposed dump leach foundation.

Two sheets of 60 mil HDPE will be used in conjunction with a screened clay earthen liner. Two discrete leak collection systems on the basin floor will report errant leachate solution. The entire system will be overlain by a protective tails blanket. This will minimize damage from the ore loading process.

A production cistern with submersible pumps will be used to return pregnant leachate to the leach plant. It shall be installed in a sump which will allow a minimal solution head on the rest of the liner.

A system of shallow and deep wells will provide ground water monitoring. This essentially will complement the data from the leak collection system.

In concert, all these components will provide perhaps the most effective liner system for this canyon fill configuration. The design, construction, operation, and reclamation of Dump Leach 3 are presented in the body of this report. It is the intent of the Barrick Mercur Gold Mine to develop Dump Leach 3 as an environmentally sound and operationally effective facility.

Chapter II.

General Characteristics

1. Topographic Setting

The Dump Leach 3 site is located in the central portion of Meadow Canyon, which is tributary to Mercur Canyon. This area of Meadow Canyon lies along an approximately north-south line, with the north end aligned in an easterly direction. Drawings 8.89.1,2 show the general layout.

The canyon walls slope at nominally 1.8 - 2.5:1 with the west-facing slopes marginally steeper than the east-facing wall. Underneath the dump leach, the canyon floor descends at approximately a 12:1 grade.

2. Geologic Setting

Meadow Canyon is an erosional feature on the eastern limb of the northwest-trending Ophir anticline. Bedding within the canyon dips between 10° and 31°, averaging about 20° toward the northeast. The upper member of the Mississippian Great Blue Formation underlies the proposed dump leach location, as shown on Figures 2-4. The upper member is characterized by a thick sequence of fine-grained limestones. Within Meadow Canyon, the member is dense and nearly pure limestone with nodular and bedded cherts. Fossils, especially crinoids, are common. Some beds contain some silt and sand.

Faulting within the canyon appears to be minimal. The Meadow Canyon Fault (Figures 2-4) has been inferred from drill sections and topographic features. The fault appears to be normal, with the down-dropped block to the east. This is compatible with the downwarping along the eastern limb of the anticline. The date of faulting is estimated between late Cretaceous and mid-Miocene.

Within the canyon, the upper and midslopes are bare or covered with a thin unconsolidated colluvium. The lower slopes and canyon bottom contain up to 40 feet of unconsolidated colluvium and alluvium. Similarly, topsoil thickness grades from discontinuous and thin on the upper slopes to a depth of several feet in the canyon bottom.

3. Surface Hydrology

The drainage in Meadow Canyon is ephemeral with very infrequent flow. No continuous flow has been observed during the life of the mine since 1982. The active channel width at the canyon mouth is only 3.5 feet. This implies an average flow of less than 20 gpm (Appendix A). That design flow will be handled with a subdrain. The subdrain has a capacity of approximately 900 gpm. Inlet basins will direct runoff into the subdrain. The below-grade diversion structure is shown on drawings 8.88.2, 3.

During normal, non-flood operation, this structure will draw moisture from the overlying dump leach foundation. This is done through the incorporation of perforated pipe sections. This capability will also reduce pore water pressure within the Stage I embankment portion of the proposed dump leach foundation.

Using the SCS Curve Method, the estimated peak runoff from a 100 year, 24 hour storm event is 40 cfs (JBR Consultants Group, 1990). The flow volume is 198 acre-feet. This flood will be handled by both the subdrain and a diversion berm. The inlet basins will direct most flow into the subdrain. Any overflow will be directed away from the dump leach by the diversion berm and road system. All flow which has been diverted will proceed into the Golden Gate or the Lady May pit. The existing haul roads and their berms will control flow south of Dump Leach 3.

The subdrain and berm combination is used to minimize environmental degradation caused by surface diversion ditches. In lieu of the existing design, several thousand feet of ditching would be necessary. Such construction would result in a sinuous road system extending well beyond the mine permit boundary. Several areas would require drilling and blasting to construct the ditches. The subdrain and berm combination is more prudent, both operationally and environmentally.

Additional aspects of runoff diversion are addressed in Section III.8.

4. Ground Water Hydrology

Ground water occurrences in Meadow Canyon are similar to other nearby locations in the Mississippian Upper Great Blue Formation. Ground water underneath the proposed dump leach can be characterized as deep and low volume.

As shown in Figures 3 and 4, water has been consistently encountered near the top of the Long Trail Member. This phenomenon has been common throughout the district. The Long Trail is a carbonaceous fissile shale with about 20% smectites (swelling clays). These clays contribute to a very low permeability, so the unit functions as an aquitard to an aquiclude.

Two drilling programs have been undertaken to confirm or deny gold mineralization in Meadow Canyon. The hydrologic aspects of the 1988 drilling were consistent with the 1980 investigations. The recent drilling indicated flows of 20-40 gpm. Water elevations were compatible with the geology.

Presently, there are no indications of potable use of this groundwater; past, present, or future. Stratigraphically, this water would appear to lie below the aquifers which supply Cedar Valley. It is confined from comingling by the overlying Manning Canyon Shale, which is 1300-1600 feet in thickness (Hintze, 1988). Topographically, flow may discharge along strike, perhaps 30,000 feet to the south, in either Wells or Manning Canyons. At that point, possible flow would enter the alluvium and proceed easterly some 18,000 feet toward the Fairfield pumps. The Wells-Clay Canyon thrust (Tooker, 1987) could confine this flow from discharging to the alluvium. In that event, flow would remain stratigraphically confined from potable use.

A thorough review of the ground water hydrology can be found in the companion document "Ground Water Assessment for Dump Leach #3" (Dames & Moore, 1990). That report concurs that ground water is found only at great depth. The chance of significant impact from process water spills or leaks is remote.

Chapter III.

Design Characteristics

1. Leach Plant

The Dump Leach 3 process plant will be located immediately northeast of the leach basin. Pregnant (gold-bearing) solution from the dump will be introduced to five carbon columns. The carbon will adsorb gold from solution. Carbon will then be trucked to the Mercur mill for recovery of adsorbed metal.

The plant will consist of open-air columns erected upon a sloping concrete foundation. All adjacent ground will also be sloped so as to direct any solution spillage or runoff onto the dump leach liner. Sloping of the plant pad will also minimize structural steel supports.

A modest operations/maintenance building will be constructed adjacent to the columns. This building will house controls and tools for the functioning of the facility. There will be two primary accesses to the plant. The main access will be across the south side of the leach pad and then along the east side. A secondary access will be from the Reservation Canyon Tailing Impoundment. That will run adjacent to the makeup water pipeline, and will approach from the southeast. A third access is along the west side of Dump Leach 3. Since that is also the mine haulage route, process traffic will be minimized.

Figure 5 shows a generalized flowchart of the plant. Design and average flows are called out, along with tonnage rates, where applicable. Figure 6 is the commensurate piping and instrumentation drawing.

Reclaim water will be piped from the tails pond to the barren solution surge tank. That design flow will be 125 gpm, with an expected average of 100 gpm. The surge tank will be constructed of mild steel, and will have a capacity of 100,000 gallons.

The barren solution in the tank will be kept at a minimum of 60°F by heating a circulating bleed stream. That stream will pass through an auxilliary propane fired heat exchanger and return to the surge tank. Emergency flow and cleanouts will be routed across the plant floor and into the spill containment drain.

A mixture of caustic soda and 20 percent (wt.) sodium cyanide (NaCN) will be off-loaded from a truck into a storage tank. The caustic soda is used to maintain a pH of 10 or greater. This is standard practice to eliminate the creation of hydrogen cyanide gas. These reagents are pumped to the barren solution surge tank as required.

Operation will be facilitated by introducing a descalant solution into the surge tank. This will be pumped from a separate truck-loaded storage tank.

The barren solution will be pumped to the dump leach at an average rate of 1100 gpm. A peak flow of 1375 gpm is designed. This will deliver free cyanide at a concentration of 0.8 lb/ton (.0016 mg/l) of solution. The barren solution distribution system is discussed in a following section.

The pregnant solution (or return) line will return flow at an average rate of 1000 gpm, with a design capacity of 1125 gpm. The pH will be approximately 9, with a free cyanide concentration of 0.5 lb/ton (.0010 mg/l) solution.

The solution will be returned to the columns, which will have a 40-mil thick coal tar epoxy lining. They will be covered with lids for protection and heat retention. Inspection ports will be provided for maintenance. Bypass piping will afford production and maintenance flexibility.

The pregnant solution will be introduced to the first column, and will gravity flow through it and the subsequent four units. Fresh carbon will be pumped into the fifth column, and will travel subsequently through the preceding four. In this manner, a highly efficient counter-current flow is used to maximize recovery.

Carbon which has been loaded to approximately 100-150 oz/ton gold will be educted in 2-ton lots into a truck mounted transfer bin. The bin will have provision for dewatering the carbon, with that water returning to the leach plant process flow. The bin will be transferred to the mill for carbon stripping. This will entail unloading the bin into the acid wash tank in the bullion room.

The empty carbon transfer bin then will be filled with regenerated carbon via an extension of the present recharging system. The loaded transfer bin will be lowered to the truck for return to the leach plant.

2. Distribution Lines

The barren solution distribution system is shown on Drawings 8.89.1-4. The main line will be a 10-inch diameter HDPE pipe. It will be routed in a spill containment channel from the barren surge tank to the dump leach liner.

The liner anchor trench will be configured to provide spill containment within the dump leach itself. A shelf will be made just inside the anchor trench. The process lines will lie on this shelf, assuring that any spill will stay within the dump leach basin.

Drawing 8.89.2 shows a schematic layout of the emitter system as it may appear on the final lift of leach ore. The emitter lines are a drip irrigation system similar to those used in agricultural applications. They are efficient and environmentally benign. The lines lie on the ore and drip directly on it without spraying solution through the air.

The solution percolates through the ore and courses across the liner to the production cistern. The cistern will house the pump which charges the return lines with the now-pregnant leachate solution. The return line will lie on the spill containment shelf along the east rim of the dump leach. The return line will also be a 10-inch diameter HDPE pipe.

3. Make-Up Water Lines

Make-up water with an average free cyanide concentration of 40 mg/l will be piped from the tailwater pond in Reservation Canyon. The pipeline will be a 10-inch diameter HDPE pipe. It shall lie in a half culvert which will serve as spill containment. The make-up water will be routed to the barren solution surge tank where it will be charged with reagents prior to pumping onto the dump leach.

Appropriate instrumentation will be installed to detect leaks and minimize potential environmental degradation.

4. Power Supply

The leach plant and ancillary services will be powered by a nominal 4 kV line from Reservation Canyon. A single-pole line will be erected as shown in plan view on Drawing 8.89.1.

5. Embankment Stability

The Dump Leach 3 foundation will be constructed in two stages. Stage I will consist of approximately 5.1 million tons (Mt) of waste rock. This is shown on Drawings 8.89.1 and 8.89.3. Table III shows the foundation quantities involved in Stage I.

All of Stage I will be completed prior to construction of the liner. A significant portion of Stage I will serve as an embankment across the southern limit of the dump leach.

Stage II will extend southward from the initial embankment. It will cover the original 2:1 face slope. The ultimate face slope will approach 4.5:1. The final quantity in Stage II will be dependent upon haul distances and waste scheduling during the ensuing years of mining. It is envisioned the Stage II quantity will be similar to the amount in Stage I.

A number of different stability analyses were done on the Stage I face of Dump Leach 3. In addition, comparative analyses were performed on Dump Leach #2. Both the Janbu and the Modified Bishop's methods were used. (Carpenter, 1986, Hoek & Bray, 1977, Lovell et al., 1984, Siegel, 1975).

Earthquakes were simulated by applying 0.1g horizontally outward. It should be noted that tailing dams at Mercur are designed with 0.05g horizontal acceleration. The lower acceleration is compatible with expected seismic activity in the region.

Table I shows the results of those stability analyses conducted on the Stage I face. Prudent engineering requires the static equilibrium safety factor to be greater than or equal to 1.5. The pseudo-static factor should be 1.10 or greater, in order to be compatible with the tails dam design constraints.

As shown in the table, these limits have been exceeded, resulting in a sound design. The stability will only increase with the construction of Stage II. The lower Meadow Canyon Dump will provide an extensive buttress across the face of the dump leach. The safety factors will be even higher than for Stage I.

The timing of Stage II will be such that the waste dumping will be in progress throughout the loading of Dump Leach 3. The toe area of Stage I will be buried

first. Table I and Appendix B show the 2:1 toe was the critical region for that design.

It is pertinent to note the robust nature of the proposed ore loading. Both the side and face slopes of Dump Leach 3 are planned at 1.5:1, essentially the angle of repose. It can be seen that the stability of the ore heap will be assured.

6. Foundation

The Dump Leach 3 foundation serves several purposes. The objectives were reached by careful consideration of construction techniques, site selection, and long range mine plans. The salient purposes are:

6.1 Creation of a 3:1 slope. The natural canyon walls slope at 1.8:1 to 2.5:1. Those angles are too steep to allow safe and efficient construction of an earthen or a composite liner. In previous efforts, the Mercur Mine has successfully compacted Long Trail Shale on 3:1 slopes.

6.2 A canyon fill configuration maximizes ore tons per acre of disturbed ground. The design provides for 21 acres of liner, upon which 6.46 Mt of sub ore can be placed. The basin itself stores 2.85 Mt, with the balance of 3.61 Mt heaped above the rim of the bowl. Thus, the canyon fill configuration provides nearly an additional 80% capacity (6.46 vs. 3.61) above a commensurate flat pad design, with the same degree of environmental impact. This canyon fill dump leach thus is shown to be the best match of both environmental and operational concerns.

6.3 A canyon fill configuration minimizes the total waste rock impact upon the environment. Approximately 5.1 Mt are required to construct the Stage I foundation, covering nearly 26 acres. Were this tonnage not placed in the foundation, it would be placed on dumps elsewhere, possibly with a commensurate coverage of area.

6.4 A canyon fill configuration provides for a process-pond-in-leach. Utilizing the basin as a pregnant solution pond avoids the additional environmental disturbance of constructing a separate process pond. The proposed permanent pool at 7060 elevation covers 3.3 acres at an average depth of 15 feet. At 25% void space, this provides 542,000 CF or 4 million gallons of solution. A separate pond at a uniform 15-foot depth would cover nearly one full acre. Since a uniform depth will not be constructed for an earthen

liner, at least 2 acres would be required. The additional pond would potentially compound both environmental and operational difficulties.

6.5 The bowl-shaping provides select fill for the foundation surface. This is because final shaping, prior to liner placement, will be done with finer material. This select fill will then be moistened and compacted to provide a smooth surface for placement of the first layer of synthetic liner.

6.6 Construction by lifts assures uniform compaction of the foundation. Run-of-Mine (R-O-M) fill has been used for the fill. This is primarily blasted rock, with some comingled subsoil and shales which did not require blasting. Being predominantly rockfill, no compactive effort was necessary to assure immediate settlement. Only minor long-term consolidation is to be expected, and that would occur within the construction time period. Foundation construction is estimated at 13 months, with a total of 16 months between foundation initiation and liner initiation.

Classical consolidation analyses (Costa and Baker, 1981, McCarthy, 1977, Smith, 1968) were performed to assess worst-case effects (Appendix C). The calculations indicate only a moderate settlement is expected, and all of that will occur during construction. The nominal 10-foot lifts will assure this. Thus, no significant post-construction settlement will impinge upon the integrity of the liner.

7. Liner

7.1 Design Considerations

A three-part composite liner is proposed for Dump Leach 3. The design is the result of a concerted effort over a period of nearly three years. Experience gained in the construction of Dump Leach 1 and 2 was relied upon heavily. Considerable attention was paid to construction techniques and subsequent effects of ore loading.

The design and construction of liner systems for solid waste storage demands a departure from liquid storage norms. Liquid storage systems are loaded hydrostatically. This fact allows considerable design flexibility in configuring all components of a liner. With solid systems, differential and point loads are the rule rather than the exception.

Both types of containment structures require firm foundations with minimal post-loading deformation. Liner components of both can be configured to withstand some degree of relatively uniform deformation.

Degradation or failure of a liquid-loaded liner is essentially a hydraulic failure. That is, the uniformly loaded liquid finds a pre-existing sheet, seam or earthen liner defect. Solid loading increases the opportunity for creating a mechanical failure, which is obviously also a hydraulic degradation.

With solid loading, minimizing the opportunity for mechanical failure becomes paramount. The importance of this design statement becomes apparent when considering the loading equipment itself. Though low ground pressure dozers can be used to spread the protective tails blanket, haul trucks will be used for the actual loading. When fully loaded, the 85-ton capacity units have a gross weight of approximately 165 tons, distributed over six wheels. It is instructive to consider that an interstate highway-rated tractor trailer grosses approximately 40 tons. The highway vehicle distributes its load over 18 wheels.

On Dump Leach 1 and 2, the liner consisted of the following components, listed from top to bottom:

1. Tails blanket - protective cover
2. 40-mil LLDPE - FML or secondary liner
3. Geogrid - leakage detection component
4. Geotextile - leakage detection component
5. Clay liner - earthen or primary liner
6. Foundation - prepared surface

The leakage detection components form a layer which allows for depressurization of the liner in the event of a leak. Unfortunately, they also provide a slip plane within the liner.

Such slip plane development was evident during the construction of Dump Leach 1 and 2. While placing the tails blanket, the HDPE was observed to readily creep across the drain net layer. This occurred on slopes ranging from 12:1 (8%) to 3:1 (33%). Creep of the FML led to wrinkles and folds which may have cracked under

subsequent loads. It is likely these folds did crack, as leakage was virtually coincident with the initial production.

With this failure pathology, it became a priority to design a liner with as uniform a mechanical behavior as possible. By designing for a uniform response to both construction and operational loads, the risk of overstressing an individual component could be reduced. A synergistic behavior was sought, whereby the integrity of the total system could perhaps exceed the mere additive effects of the individual parts (Conlin, 1985, Leach et al., 1987).

7.2 System Components

The liner design which has been selected is shown on Drawings 8.89.3 and 8.89.4. The conceptual component configuration is listed below, in descending order from top to bottom.

1. Tails blanket - protective cover
2. 60-mil textured HDPE - FML tertiary liner
3. Clay liner - earthen or primary liner
4. Gravel/Geotextile channel - primary leak collection
5. 60-mil textured HDPE - FML secondary liner
6. Gravel/Geotextile channel - secondary leak collection
7. Foundation - prepared surface

7.2.1 Tails Blanket

The material to be used is the tailing from the turn-of-the-century era Golden Gate mill. The grind was 3/8 x 0 (Maguire and Howard, 1913, Klatt, 1975). The tails have been rain-washed to result in a sandy gravel with a clay matrix. This product has been used as the protective liner on Dump Leach 1 and 2. Its hydraulic performance has been excellent, indicating permeabilities no lower than $1x10^{-3}$ cm/s.

7.2.2 60-mil textured HDPE

The tertiary liner is the initial containment barrier which fluids will encounter. Its object is to maintain operational viability by preventing significant loss of leachate, or pregnant solution. The "preg-robbing" characteristics of the underlying

clay liner require robust integrity in the flexible membrane liner (FML).

Assurance of environmental integrity is an obvious corollary to production efficiency. The added thickness will provide more resistance to punctures due to ore loading. Perhaps more significantly, a third party will be retained to verify the seam integrity of the installation. The installation specifications are contained in Chapter IV of this document.

The textured sheet will provide two significant mechanical benefits. The high friction angle (30° is not unreasonable to expect) will minimize slippage on the top surface while placing the tails blanket. The same phenomenon will bond the sheet to the underlying clay. That will diminish the in-sheet load and significantly reduce sheet elongation and stress along or across seams.

Appendix H presents technical data related to various HDPE liners currently available.

7.2.3 Clay Liner

The moistened and compacted Long Trail clay will form the primary liner. It is considered the primary as its chief purpose is to prevent environmental degradation. It will continue to function even if deformed under an extreme point load. Historically, permeabilities much lower than $1x10^{-7}$ cm/s have been achieved. Samples 1-3 on Table IV are indicative of the expected permeabilities for this clay.

The cyanide attenuation characteristics of the clay indicate that virtually all the cyanide from small leaks in the overlying FML may be consumed during dispersion through the clay. Appendices F and G present calculations supporting that statement. The effectiveness of attenuation processes in contaminant containment are becoming more recognized (Rouse, Pyrih, 1988, Pyrih, Rouse, 1989). The Long Trail Shale apparently will consume at least 0.68g CN/g shale (Chatwin, 1989).

Underneath the permanent process pool, a minimum of 2 feet of compacted clay will be placed. Elsewhere in the liner, a minimum of 1 foot in thickness will be used. It is important to note the historical pattern in earthen liner thickness. Due to the soil creep induced by the placement and compaction efforts, the lower slopes and basin bottoms have always had extremely thick liners. The liner at the bottom of

Dump Leach 2 has areas exceeding 5 feet in thickness. Similar results are expected for Dump Leach 3. A third party will be retained to assure compliance with construction specifications. Those specifications are contained in Chapter IV of this document.

A detailed discussion of hydraulic performance follows the listing of the remaining components.

7.2.4 Primary Gravel/Geotextile Channel

This primary leak detection channel is designed to operate in a similar manner as a french drain. It will serve to transmit leakage down the axis of the permanent pool to the leakage collection system.

Construction of a soft, deformable roll (Drawing 8.89.4) avoids one of the significant difficulties with leak detection systems in composite liners. Stiff piping is prone to buckling and fracturing under either the construction or production loads. Such fracturing was documented in the liner construction test (Gili, 1989) noted in appendix E. The result of that failure can lead to puncturing either or both the overlying and underlying liner.

A heavy weight (minimum 10 oz) geotextile cloth will be rolled around a washed gravel core. The core will have a nominal 1-foot diameter. The cloth will be heat seamed to provide a firm roll. No sharp edges will be exposed to any liner components.

7.2.5 60 mil textured HDPE

The secondary liner exclusively serves as an environmental barrier. Any leachate reaching this barrier will contain only minimal amounts of gold, so little economic benefit is expected from its containment. The minor amount of contained cyanide will be further impeded by this FML. As such, environmental protection is its sole function.

The mechanical integrity of the secondary liner is equivalent to that of the tertiary liner. The frictional characteristics of the textured sheet have proven compatible with the proposed construction technique (Gili, 1989).

7.2.6 Secondary Gravel/Geotextile Channel

The secondary leak detection channel serves to indicate whether there has been a complete liner failure underneath the permanent process pool. This structure is configured the same as the primary leak detection channel, as the mechanical and hydraulic considerations are equivalent.

7.2.7 Foundation

The immediate foundation will consist of moistened and compacted fine dirt. This will provide a firm and smooth surface for placement of the secondary FML.

Samples 7 and 8 (Table IV) indicate expected permeabilities within the foundation itself. As such, the foundation will serve as more than a receiving surface for the liner. It also will impede any unanticipated solution flow.

7.3 System Overview

The preceding paragraphs identified the main components of the liner. The overview will show how the system is expected to perform.

Robust mechanical performance will be the key to the liner's integrity. The frictional characteristics of the liner will prevent the development of slip planes. That, in turn, will allow the liner to respond uniformly to the expected loads, avoiding displacement between component layers. Such displacements would lead to the folding and tearing of the synthetic sheets.

The only mechanical discontinuity in this design is the leakage collection channel. The mechanical liability it introduces is minimized by its location and areal extent. The channel will lie along the axis of the dump, in the bottom of the basin. As such, any construction or production loads will not cause the channel to slide across the secondary liner.

The narrow width of the channels will allow careful compaction of the overlying clay liner. Compaction of that zone, using trench compactors and 4 to 6-inch lifts for the initial 2 feet, will minimize the possibility of puncturing the secondary FML.

An assured mechanical integrity makes it possible to assess the hydraulic behavior. Three methods were used to analyze the hydraulic conductivity and performance of the composite liner (Appendix G). The first was a theoretical approach which considered the liner components in series. The second method was based on an experimental study of discrete flaws in flexible membrane liners (Jayawickrama et al., 1988). The third was an interpolation of theoretical and experimental work to arrive at an empirical evaluation of composite liners (Bonaparte, et al., 1989).

Total process flows, at 1,000 gpm, will be 525,600,000 gpy. Maximum expected leakage through the liner is less than 0.02% of that flow. Detection of that flow via a solution balance will be virtually impossible. The leakage collection systems will be the only way to gauge the flow, expected at less than 0.2 gpm.

The expected time required for penetration through the liner is approximately 2 years. The cyanide concentration front will lag this considerably, with the 50% (of initial concentration) weak-acid dissociable (WAD) concentration front moving at only 3.9 inches/year. (Appendix F).

It is probable that all of the cyanide will be contained within the clay liner during the planned life of the dump leach. The liner will consume at least 0.68 mg free cyanide per gram of clay. The liner underneath the permanent pool can absorb over 25,000 lb of cyanide. At a concentration of 260 ppm free CN, leaking pregnant solution will introduce less than 220 lb CN per year (Appendix G). Thus, in seven years time, the clay liner would still be able to consume a considerable amount of contaminant, preventing its escape beyond the containment system.

Given the secondary leak collection system and the low permeability of the 90-foot thick foundation (Table IV), the probability of any contaminant discharge to the underlying soil and rock is extremely remote. There is an even lower expectation for discharge through an additional 120 feet (Figs. 3 & 4, Y-19) to ground water.

To summarize, it must be stressed the calculations in this overview are based upon design parameters. Historically, the as-built clay liners have exceeded those specifications. The liner thickness is expected to be greater than design. Additionally, the expected permeability will be much lower than the allowed maximum. These two characteristics reinforce the expected performance as discussed above.

By design, the composite liner presented here is perhaps the best match of environmental, production, and construction requirements. It is highly improbable that a significantly more effective liner can be constructed over such a large area with these slopes.

8. Runoff Diversion

The diversion structures have been designed for the 100-year storm event. This is compatible with

previous permitted structures in Meadow Canyon (JBR, 1986).

The topography of Meadow Canyon is such that diversion ditching would lead to a signficant amount of environmental damage up-canyon from the dump leach. Several thousand feet of ditches would be required on both sides of the canyon. The utility of the structures is suspect given the recent precipitation history. In 1983, a ten-year storm hit Mercur Canyon and its tributaries. Virtually no runoff accumulated in central and upper Meadow Canyon. Evidently this is due to the extremely high infiltration rate in those portions of the canyon. Though a 100-year storm would certainly induce greater runoff, perhaps it would not approach the estimated 430 cfs.

Given the likely under-utilization of diversion ditches, a two-component alternative is proposed. One component involves a subdrain in the original canyon bottom. With the exception of the drainage immediately upslope of the dump leach, all runoff is directed into the subdrain system.

The subdrain is designed to transmit 900 gpm through a nominal 6-inch diameter polyethylene pipe (Appendix A). There are two inlets to the system. One is in Dead Horse Canyon, the other is in upper Meadow Canyon. The inlets are wrapped in geotextile and shielded with riprap (Drawing 8.88.2). They will lie in the bottom of inlet ponds formed by the upper ends of the dump leach foundation fill. The second component is the roadway-and-berm configuration shown on drawings 8.89.1-4. The normal 5-ft high safety berm will be constructed of compacted fill. It will thus create a barrier directing excess runoff onto the 75 to 100 ft-wide access and haulage roads. The surface diversion system will have a capacity in excess of 500 cfs. The 100-year event may induce a flow of 430 cfs. This continuous system will also accept overflow from the inlet basins, and divert all runoff into the mine workings at the canyon mouth. There it will enter the existing runoff diversion and control system.

Overflow into the surface diversion system will occur only when the inlet basins are filled. The Dead Horse Canyon basin has a flood capacity of 62 acre-feet, and the Meadow Canyon basin will detain 61 acre-feet.

These are only detention basins since the subdrain inlets are located at the very bottom. Their combined detention capacity is 62% of the 198 acre-feet 100-year storm event. It can be seen that both components provide a prudent and environmentally responsible runoff diversion system.

During non-flood periods, the subdrain functions to assist in dewatering the foundation. Sections of perforated pipe are placed every 400 feet along the drain. These are wrapped with geotextile and sheathed in a protective length of 8-inch diameter pipe. They are bedded in a sand which will facilitate the flow of water into the pipe. This also allows the subdrain to function in some capacity as a leakage detection system.

Chapter IV.

Construction Procedures

1. Subdrain and Diversion System

The subdrain and diversion structure construction are shown on Drawing 8.88.2,3 and 8.89.1-4. The actual construction was preceded by removing the topsoil within the impacted area. The soil was relocated to stockpiles 7A and 15.

Subsequently, the subdrain was installed in a trench as noted on the drawings. The pipe was bedded and then backfilled for protection from the foundation fill.

The surface diversion ditches are constructed to direct runoff away from the dump leach liner. The west and east access roads will grade away from the anchor trench so that runoff will move outwardly around the perimeter. Flow will then proceed in a southerly direction down the access ramps. At the base of the ramps runoff will proceed to the existing runoff control structures in lower Meadow Canyon and Mercur Canyon.

2. Foundation

The dump leach foundation will be constructed of run-of-mine (R-O-M) waste rock and earth. The material shall consist primarily of blasted rock from the pit. The source will be mostly limestone, sandstone, shales and chert from the Mercur Member of the Mississippian Great Blue Formation. There will be lesser amounts of soil placed in the dump. The term "soil" is used to denote fine earth material, including weathered or degraded rock. The soil and some of the shales will not require blasting. All of the waste shall be delivered as available from the active mine.

At the 7020 Elevation, a flat dump shall fill the canyon. This will require approximately 1,541,000 tons (Table III), to be placed in roughly 4 months. Following completion of the 7020 dump, the balance of the foundation will be constructed in lifts of 10 feet height. This will continue to the 7150 Elevation.

Construction by lifts will afford compaction to the finer material, the shales and the soil. That assures their mechanical compatibility with the surrounding rockfill. The compaction is applied by the haulage

units themselves. The loaded trucks weigh 165 tons and can achieve the required settlement in the course of normal operation.

Shaping of the basin is facilitated by placing only the fine material along the inside of each lift. This is done for two reasons. Dozers can work the fine material more easily to achieve the required slope. In addition, the fine material is required as the foundation for the lower sheet of polyethylene. In general, material placement is more reliable when discrete lifts are the construction method.

Survey control is also more practical with lifts. That provides for a better overall slope shape, in addition to tighter material control.

The final stage of foundation construction will be slope preparation. This will involve attaining the final grade with dozer and grader operation. A nominal six inch thickness of dirt fill will be spread over the entire basin. This then will be moistened and rolled with a smooth drum vibratory compactor. A nominal 20-ton unit will make four (4) passes to smooth and compact the surface.

The compactor will operate with a belaying cable as described in Appendix E. This will serve both for safety and efficiency. The safety implications are obvious. The efficiency of compaction is enhanced since when belayed the unit can operate with the vibrating drum down slope. This makes full use of the machine weight distribution, and further assists in preparing a smooth, well-compacted surface for liner installation.

An important detail of the final slope preparation will be the cistern sump. This will be shaped from the foundation fill. Hand-operated compactors will be used for the irregular slopes in the sump area. The nominal low elevation will be 7030.

3. Liner system

3.1 Secondary Leak Collection Channel

A nominal 12-inch by 12-inch trench shall be excavated in the lowest point of the basin axis. The excavated material shall be feathered across and rolled into the foundation surface. The channel will be fabricated prior to placement in the trench.

Fabrication will consist of rolling a nominal 12-inch diameter core of gravel inside a geotextile cloth. The length of roll will be dictated by practicable handling. Individual segments or sacks can be overlapped end-to-end to construct the full channel. Heat seaming will be used to bond the geotextile. The use of wire, cable ties, or other mechanical devices will not be permitted.

The gravel roll will be tamped into the trench. Fine sand or loose dirt will be placed, where necessary, about the roll to afford a smooth bed for the overlying plastic sheet.

The inlet end of the secondary channel will extend to a nominal 7040 elevation, approximately 200 feet from the discharge point. The discharge end will lie directly over the secondary leak collection riser. An inlet gradient will be formed over the riser by shaping clay underneath the gravel channel. Either native Long Trail or imported bentonite will be tamped around the riser and riser inlet.

The riser orifice itself will be wrapped with geotextile to function as a filter cloth. The leakage channel will be placed directly on the filter cloth to assure transmission of water into the riser.

3.2 Secondary HDPE Liner

The HDPE liner shall be fabricated and installed to meet the intent of the Hazardous and Solid Waste Ammendments of 1984 to the Resource Conservation and Recovery Act (RCRA). Specifically, installation shall comply with the 'Construction Quality Assurance for Hazardous Waste Land Disposal Facilities, Public Comment Draft,' (EPA Document/530-SW-85-021, October 1985).

The material to be used will be a high density polyethene (HDPE) sheet. It shall be textured on both sides to enhance its frictional characteristics. The nominal thickness shall be 60 mils (0.060 inch). Appendix H presents technical data on the HDPE which is available from various manufacturers. The information is illustrative, and is not intended to be exhaustive or all-inclusive.

Installation shall be according to the highest standards of the liner industry (Gundle Lining Systems, 1988, National Seal Company, 1989, Poly-America, Inc., 1987, Schlegel Corporation, 1986). Quality assurance of the installation shall be

performed by a third party (i.e. distinct from both the Installer and the Owner (Barrick)).

The Installer shall make available to the Owner and the liner Quality Assurance supervisor a plan map showing the proposed sheet and seam layout. Sheets and seams shall be numbered for identification. This map will be used to gauge progress and record the installation and quality assurance history.

Destructive shear and peel tests will be conducted on a frequency of no less than one test each per 500 feet of seam between regular (full roll) sheets. Seams on irregular sheets, which have been cut to fit between regular sheets, usually at the slope bottoms, shall be tested on a cumulative basis of no less than one test each per 500 feet of seam. The peel and shear tests shall be taken and reported in a timely fashion so as to minimize delay in the sheet installation.

Non-destructive vacuum tests shall be conducted over the full length of all seams. These tests shall occur as the seaming itself progresses, to minimize delay in the sheet installation.

Failure of a seam due to a destructive test will require repairs for a length along the seam reaching in both directions halfway to the adjacent test areas which passed. Failure of a vacuum test will require repair to the immediate failed area. Repair methods available include: Patching, grinding and re-welding, spot welding, capping and topping. Major repair areas will be noted on an as-built drawing.

An anchor trench shall be used at the top of the basin slopes. It shall be adequately drained to minimize ponding while the trench is open. Drainage shall be away from the dump leach basin. Material bridging and air pockets must be minimized. Thus, the anchor trench should be backfilled when the liner is in its most contracted state. Late morning to early evening should be avoided. When backfilling, care must be used to prevent damage to the liner.

3.3. Primary Leak Collection Channel

The primary leak collection channel will lie directly upon the secondary HDPE liner. A wear layer of fine material will lie between the two components. Fabrication of the channel will be the same as with the secondary channel (Section 3.1).

The inlet end of the primary channel will extend to a nominal 7040 elevation, approximately 200 feet from the discharge point. The discharge end will lie directly over the primary leak collection riser. An inlet gradient will be formed over the riser by shaping both the foundation and the secondary HDPE sheet. Either native Long Trail or imported bentonite clay will be tamped around the riser and riser inlet. The secondary sheet shall be welded to the HDPE riser using current industry practice for such joints.

The riser orifice itself will be wrapped with geotextile to function as a filter cloth. The leakage channel will be placed directly on the filter cloth to assure transmission of water into the riser.

3.4 Primary Clay Liner

The clay is manufactured from both fresh and weathered Mississippian Long Trail Shale. The shale is processed across a double-deck screen plant. The top deck has three-inch by three-inch (3 x 3) openings, and in this application serves primarily to protect the bottom deck. The bottom deck has a 1 x 1 opening, producing a relatively fine shaly clay.

The final product shall contain no individual particles greater than three inches in size. The clay shall contain no more than 2% by weight roots, organic or other deleterious material. Deleterious material includes fragments of sandstone.

The following are the in-place gragation requirements:

U.S. Standard Sieve Size	Minimum Percent Passing by Weight
3"	100
2"	90
3/4"	80
1/2"	70
# 4	50
# 40	30
#200	20

The clay should not be gap-graded or skip-graded in any manner which would increase permeability. In addition, the Plasticity Index shall be greater than or equal to ten.

Clay shall be compacted to not less than 95% of maximum dry density as per the Standard Proctor Test (ASTM D-698-78). Field tests will be done with a

nuclear density gauge (ASTMD-2922-81). Nuclear Density tests will not be conducted until the proper thickness has been reached. On the one-foot thick liner portion, the probe hole will not exceed 10 inches in depth. On the two-foot thick liner, the probe hole will not exceed 18 inches in depth. All probe holes will be tamped with a powdered bentonite backfill.

Permeability will be tested in accordance with the US Army Corps of Engineers procedure EM11110-2-1906. This describes back-pressure permeameter with a triaxial cell. The maximum allowable permeability will be 1×10^{-7} cm/s.

Testing shall be conducted on the following frequencies:

TEST	GRID	FREQUENCY
Thickness	25 x 25	(1/625 ft^2)
Field Density	50 x 50	(1/2500 ft^2)
Laboratory Suite: Proctor Test, Gradation Test, Atterberg Limits	100 x 100	(1/10,000 ft^2)
Permeability Test	100 x 200	(1/20,000 ft^2)

The earthen liner shall be constructed by dumping clay on or near the backfilled anchor trench. The clay will be spread downslope by tracked dozers of a nominal 54,000 lb. GVW or lighter.

Compaction will be attained by using a vibratory smooth drum roller of a nominal 20-ton static weight. The compactor will be secured in a manner similar to that described in Appendix E (Gili, 1989). That will ensure operator safety and mechanical efficiency. Compactive efforts will not begin until a minimum of 16 inches of loose clay has been placed in an area.

In the area underlying the permanent process pool, two lifts shall be compacted. Each lift shall have a minimum compacted thickness of 12 inches. The clay for the second lift may be transported using front-end loaders if the slope is not subject to rutting by such traffic. The alternative is to doze all the new clay downslope, which may require re-establishing quality assurance on the upper slope.

Overlying and adjacent to the production sump and primary leak collection channel, clay placement will be done with small equipment and the utmost care.

Skid steer loaders may be used for placement. Hand directed compactors will be used in these areas.

Following successfull compaction, dessication of the clay must be avoided. Periodic wetting of the surface will be performed until the tertiary HDPE sheet is overlain.

3.5 Tertiary HDPE Liner

The tertiary liner shall be fabricated and installed in the same manner as the secondary sheet. Installation and quality assurance will follow the same precepts.

Along the east edge of the dump leach, the anchor trench for the tertiary liner must include provisions for the production piping (Drawings 8.89.1-4). Around the entire perimeter, care must be taken to keep the tertiary anchor trench outboard of the secondary trench.

3.6 Tails Blanket

The protective cover shall be placed to a minimum thickness of two feet. It shall be spread in the same manner as the primary liner was placed. This thickness shall be increased to five feet in the area where the loading ramp will lie. That thickness will be established prior to the movement of traffic required for the cistern construction. Sub ore haulage will require an additional five feet of ore as a working surface. This will assure the loaded haul trucks will have a nominal ten feet of material between their tires and the upper sheet of HDPE.

Placement of the tails blanket may occur all or in part as an integral phase of the sub ore loading exercise. A description of that construction technique is included in Chapter IV, section 1. At this point, it is important to note that the initial lift of sub ore will be underlain by a full five feet of tails. This thickened blanket will cover approximately 0.75 acre on the basin floor around the sump.

4. Distribution and Make-up Water Lines

The various process solution lines shall be sited and constructed as shown on drawing 8.89.1-5. HDPE piping will be used whenever possible. Joints will be welded unless fittings or practicality require mechanical connections.

Piping will be installed with positive spill containment. Half culvert sections will be used where possible. These will be corrugated metal, concrete, HDPE or PVC as appropriate at the discretion of the Construction Engineer. Synthetic-lined ditches may be used. In that application, the synthetic must be resistant to solar and thermal degradation, or further protected from same.

Full culvert sections will be used where traffic needs so dictate. Appropriate construction material and methods will be used.

Along most of their length, the barren and pregnant solution lines will be sited directly on the dump leach liner. This will serve as a spill containment measure.

All spill containment devices ultimately will direct their flow onto the dump leach liner. Following spill mitigation, the errant solution will be reintroduced to the process at the production cistern.

The leak collection return line will be constructed without spill containment. The expected low volume and intermittent use do not warrant such devices. Future installation of same may be appropriate if flow significantly exceeds projected levels.

All piping will be installed with positive spill prevention. Prudent connection hardware and methods will be employed. Pressure relief valves, automatic shut-offs, pump controls and related instrumentation shall be employed to avoid spills and minimize their duration.

5. Plant Facilities

The plant facilities will be constructed in compliance with all pertinent Federal, State and County regulations. These will include but may not be limited to: Health, Safety, Environmental, Building codes and Electrical codes.

Specifics of plant construction are pending detailed designs and consideration of various submittals. The basic design characteristics have been presented in chapter III, section 1. The construction will conform to that design.

6. Engineering Management

Engineering management for this project will be exercised by the Barrick Mercur Gold Mine. The primary agent for the Owner in this function will be the Construction Engineer.

Other agents, internal or external to the Owner, will be utilized to assure prudent engineering of the project.

Construction itself will be effected in whole or in past either by the Owner or selected contractors. All construction will be under the direction of the Construction Engineer or his/her designated agent.

The ultimate responsibility for regulatory compliance of the design and construction as presented herein lies with the Construction Engineer and by extension, the Owner.

Chapter V.

Operating Characteristics

1. Sub Ore Loading

Sub ore is that mineralized rock which is not cost effective to crush and yet contains sufficient gold to warrant dump leaching. Under current economic conditions, it is defined as carrying a grade of 0.025-0.04 oz gold/ton. As with mill ore, the sub ore grade range is subject to market conditions. These market fluctuations then affect the amount of ore in each category.

Currently, it is expected to process approximately 5.8 Mt of sub ore on Dump Leach 3. The facility has a capacity for a nominal 6.5 Mt (Table II).

Loading will average 1 Mt/year, so that an expected life is 6.5 years. The requested design life is 7 years, which will allow for operational flexibility.

Nominal 12-foot high lifts will be loaded. Variable leaching characteristics or equipment technology may warrant periodic changes in that thickness. Current practice is to transport the sub ore in 85-ton capacity haul trucks. R-O-M sub ore is hauled onto the dump leach, dumped, and then dozed up to a uniform lift height. The working or running surface is periodically ripped to maintain good percolation characteristics. That assures recharged leaching of the subjacent lift (running surface) after a drying cycle. The drying cycle occurs immediately prior to and while the current lift is being loaded.

Using this method, ore is loaded in subparallel panels. The panel width currently is 150 feet. This width is dictated by the operating characteristics of the leachate delivery system.

Installation of the protective tailing blanket may proceed as an integral part of the loading exercise. In this event, the blanket is the first material placed against the tertiary liner. Care will be exercised to avoid dumping directly on that liner. The blanket will be spread to no less than its minimal thickness. In general, this will be no less than two feet. Under the haulage access ramp, the minimum allowable thickness of the tailing blanket will be five feet. A minimum thickness of five feet of sub

ore will overlay those tails as the running surface on the haulage access ramp.

In addition to the above procedure, the initial lift of sub ore will overlay a full five feet of tails. This will cover approximately 0.75 acre in the basin floor around the sump. This thickened blanket will further assure the integrity of the liner in the extreme bottom of the permanent process pool.

Any or all of the above operational techniques may be modified in light of new technology and/or operational experience. No modifications which diminish the ultimate liner integrity will be incorporated into current or future operations.

2. Sub Ore Leaching

Leaching will be effected through the delivery of approximately 1100 gpm of barren leachate solution. A peak flow of 1375 gpm is designed. The solution is applied through a drip irrigation system similar to those used in agricultural applications. That method is currently in use on Dump Leach 2.

This emitter system will apply approximately 0.002 gpm/sf. The peak operational efficiency will be reached when 550,000 sf of sub ore are available for leaching. This will be at a nominal elevation of 7105 feet, when approximately 999,000 tons have been loaded. Thus, it will require nearly one full year to reach the optimum leaching efficiency. This efficiency will be maintained for the bulk of the remaining life of leach.

It must not be construed that operating at less than peak leaching efficiency is always detrimental. Due to areal constraints, it is necessary in both the initial and final stages of operating any deep bowl-shaped dump leach.

The preceding exercise is presented to show that the intial leach solutions will be delivered at considerably less than 1100 gpm. This reduced rate will increase slowly through the first year of operation. Thus, that first full year will have a minimal flow, perhaps averaging 500 gpm, available for contact with the liner.

It will require approximately one month of loading to develop an area appropriate for sustained leaching. At that point, the loading route will be established

along the west edge of the sub ore surface. The barren header lines and emitter branch lines will be brought down the slope from the east.

The panels themselves will be oriented in an approximate east-west attitude. They shall be loaded in a retreat manner from east to west. This will allow orderly loading. It also permits a systematic advance of the emitter system from east to west. These attributes will be effective through the ultimate height of the dump leach.

This east-west configuration will persist in general through the life of the leach. It provides for complementary operational efficiencies of both the mine and mill departments.

During the first month of leaching, it will not be possible to operate the process or pregnant pool near the designed elevation of 7060. Loading cannot occur with the pool level close to the working surface, and the first month surfaces will be below 7060.

For most of the life of leach, it will be possible to operate with a pool at 7060. It will not always be necessary. Operating with a lower head offers a number of benefits:

a. A lower pool presents a lower head on the liner.

b. A lower pool offers increased storage for storm events or major spills. An available surge pool between 7060 and 7110 affords 1.39 Mcf (10.4 M gal) of capacity. (The historical sub ore tonnage factor of 17.7 cf/ton is used for this calculation. Voids are taken at 25%, with the sub ore 70% saturated.) With the permanent pool lowered to 7040, the surge capacity increases to 1.49 Mcf (11.2 M gal).

c. Improved aeration of the heap results in higher overall recoveries.

The above benefits must be tempered with the operational risks of an excessively shallow pregnant pool. Both siltation and cavitation of the production pump must be avoided. An irresponsibly low pool level, expecially under 10 feet, will risk such results. Pump failure due to a restrictive operating plan would be detrimental to the liner by temporarily inducing excessive heads these would occur during the failure and the subsequent repair effort. In this regard, it must be recognized that emergency surges

past the 7060 elevation may occur. In such an event, the Owner will do all in its power to return to normal operating levels in a responsible and expeditious manner.

Any or all of the above operational techniques may be modified in light of new technology and/or operational experience. No modifications which diminish the integrity of the liner or spill containment systems will be incorporated into current or future operations.

3. Life of Leach

Currently, it is expected to process approximately 5.8 Mt of sub ore on Dump Leach 3. The facility has a nominal capacity of 6.5 Mt (Table II).

Loading will average 1 Mt/year, so that a possible life is 6.5 years. The requested design life is no less than 7 years. This will allow for operational flexibility.

Liner exposure is the primary environmental concern with this dump leach. As such, it is requested that the permitted life be measured from the day of initial leachate introduction until full economic recovery of the resource has been achieved.

4. Environmental Health Monitoring

4.1 General

The operating environmental and health programs will comply with all pertinent Federal, State and County regulations: These will include but not be limited to: safety, health, air quality and water quality (ground and surface water).

Monitoring of operating conditions will be done in a diligent manner. Where appropriate, the assistance of third party agents shall be used to secure, analyze and/or verify the monitored data. Reports will be provided on a regular basis to the appropriate regulatory bodies.

In the event of a monitored departure from the accepted norm, the Owner will notify the appropriate regulatory bodies in a timely fashion. Every reasonable effort will be made to mitigate the offending circumstance. The Owner will remain

available and willing to work with the governing agencies to expedite such mitigation.

Establishment of monitoring procedures will be prepared upon final approval for construction. The procedures will be incorporated into the operating manual upon completion of construction. They shall include, but not be limited to, the following key provisions:

4.1.1 Staffing
There shall be a continuous (24 hour/day) operator presence at the Dump Leach 3 facility.

4.1.2 Plant Inspections
There shall be regularly scheduled inspections and maintenance of the facility and associated systems. This will include all of the operating systems and their appurtenances.

4.1.3 Instrumentation Inspections
There shall be regularly scheduled inspections and maintenance of the instrumentation designed for environmental and operating control. These will include, but not be limited to, liquid level alarms, pressure drop indicators, and flow meters.

4.1.4 Environmental Protection Inspections
There shall be regularly scheduled inspections of the various environmental protection systems. These will include, but not be limited to, leakage collection, the ground water monitoring, the runoff diversion and the spill containment systems.

4.1.5 Recording
There will be regularly scheduled recording of pertinent operating and environmental characteristics. These will include, but not be limited to, barren, pregnant, and make-up solution flow rates and monitor well levels.

4.2 Contingency Plans

In the unlikely event that a process spill or a liner leak occurs, a contingency plan will be implemented. The plan will include, but not be limited to, the provisions set forth below:

4.2.1 Physical Plant and Solution Lines
Upon detection of a circuit leak, rupture or other failure, all flow to that circuit will be terminated. Repairs will be effected immediately.

All solution circuits are designed for optimum containment in the unlikely event of a spill. No significant environmental degradation is likely. Any solution escaping the containment systems will be neutralized and/or recovered to the greatest extent practicable. Neutralization chemicals and equipment will be stored at the leach plant site to expedite remediation.

Any circuit failure events resulting in solution excursions in excess of the designated reportable quantities will be reported to the appropriate regulatory agency(s). In the event that initial notification was to another agency, the State of Utah Bureau of Water Pollution Control subsequently will be notified.

4.2.2 Leakage Collection System

Any solution from the Dump Leach 3 leakage collection system will be sampled upon discovery. The sample will be submitted to an independent laboratory for total water chemistry analysis. Concurrent Owner-performed analyses will investigate key leakage parameters.

The flow rate of any such discharge shall be measured with a suitable metering device. The results will be recorded on a regular basis.

The flow shall be contained and returned to the leach plant. This capture system shall use above-ground storage tanks(s), and shall be designed for zero discharge.

Monitoring of any leakage collection flow will continue on a regular basis throughout the remaining operating life of Dump Leach 3.

The State of Utah Bureau of Water Pollution Control will be notified upon detection of any verified leachate in the leakage collection system. A verbal notification will be made within 24 hours of verification. Written notification will be made within 7 days of verification.

4.2.3 Monitor Well System

The State of Utah Bureau of Water Pollution Control will be notified upon detection of any verified leachate in any Dump Leach 3 monitor well. A verbal notification will be made within 24 hours of verification. Written notification will be made within 7 days of verification.

5. Closure Procedures

Closure procedures will commence at the end of the design life. These procedures will entail alternating flushing and drying cycles. Fresh water shall be introduced to effect the flushing. The cycles will serve to flush reagents from the dump. The aeration also may enhance the overall resource recovery in this process.

When the flushed solution consistently assays at 5 ppm WAD cyanide or less, closure will be in effect. Consistency is attained when three consecutive flushing cycles report WAD cyanide levels at or below this level.

6. Reclamation

Reclamation procedures for Dump Leach 3 shall commence upon completion of mining and milling at the Barrick Mercur Gold Mine. These procedures shall comply with all pertinent Federal, State and County regulations or concurrent permitting requirements.

As planned, the ultimate closure provisions shall be similar to Dump Leach 1 and 2. These provisions include:

1. Flushing and draining of the leached material.

2. Shaping of the surface to minimize infiltration potential.

3. Placement of a low permeability cap or barrier.

4. Placement of subsoil on the cap or barrier.

5. Placement of topsoil on the subsoil.

6. Seeding for the re-establishment of vegetation.

7. Establishment of the final surface drainage around the abandoned and reclaimed facility.

The Owner stands ready to comply with the requests of the governing agency concerning this matter. Successful reclamation of Dump Leach 3 is seen as a logical conclusion to a successful design, construction and operation sequence.

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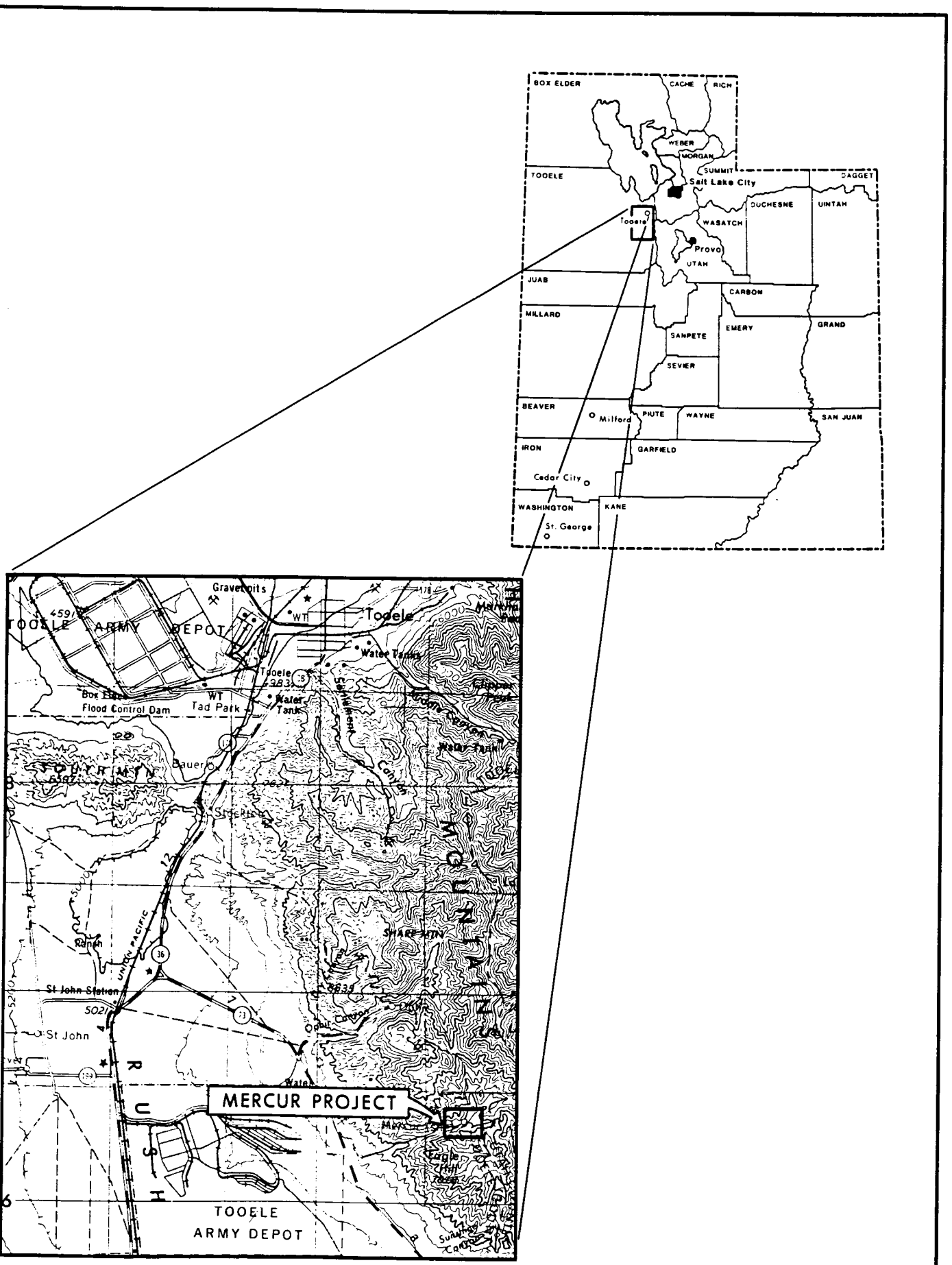
BOX ELDER
CACHE
RICH
WEBER
MORGAN
SUMMIT
Salt Lake City
TOOELE
DAGGET
DUCHESNE
UINTAH
WASATCH
Tooele
Provo
UTAH
JUAB
CARBON
MILLARD
SANPETE
EMERY
GRAND
SEVIER
BEAVER
Milford
PIUTE
WAYNE
SAN JUAN
IRON
GARFIELD
Cedar City
WASHINGTON
KANE
St. George
TOOELE ARMY DEPOT
Gravel pits
Tooele
Water Tanks
Box Elder
Flood Control Dam
WT
Tad Park
Water Tank
Bauer
Stockton
Ranch
UNION PACIFIC
St John Station
St John
SHARP MTN
Water
MERCUR PROJECT
Eagle Hill
TOOELE
ARMY DEPOT

Figure 1

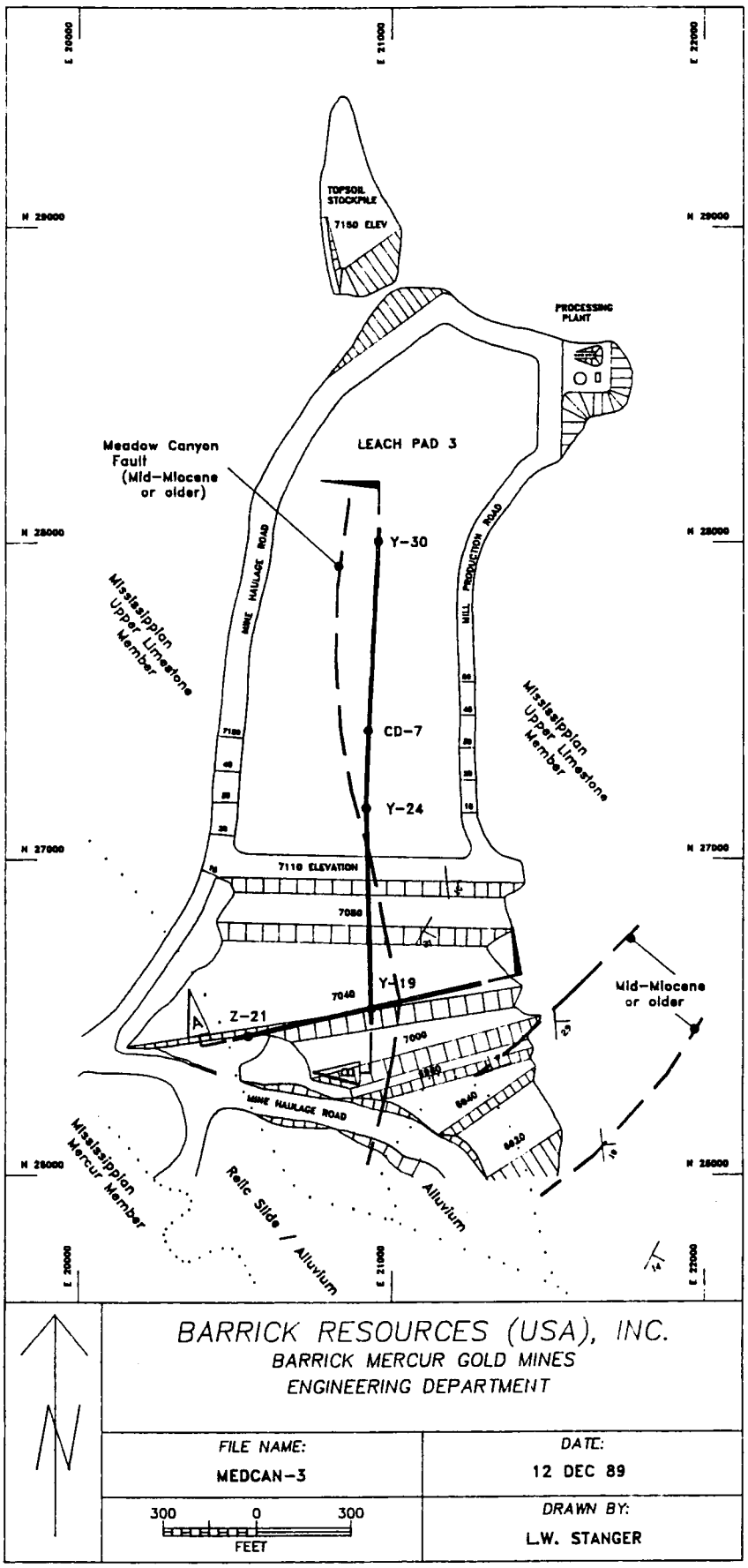
E 20000
E 21000
E 22000
N 29000
N 28000
N 27000
N 26000
TOPSOIL STOCKPILE
7150 ELEV
PROCESSING PLANT
Meadow Canyon Fault (Mid-Miocene or older)
LEACH PAD 3
Y-30
CD-7
Y-24
Y-19
Z-21
MINE HAULAGE ROAD
MILL PRODUCTION ROAD
Mississippian Upper Limestone Member
Mississippian Upper Limestone Member
7110 ELEVATION
7080
7040
7000
6960
6920
Mid-Miocene or older
MINE HAULAGE ROAD
Mississippian Mercur Member
Relic Slide / Alluvium
Alluvium
BARRICK RESOURCES (USA), INC.
BARRICK MERCUR GOLD MINES
ENGINEERING DEPARTMENT
FILE NAME:
MEDCAN-3
DATE:
12 DEC 89
300 0 300
FEET
DRAWN BY:
L.W. STANGER

Figure 2

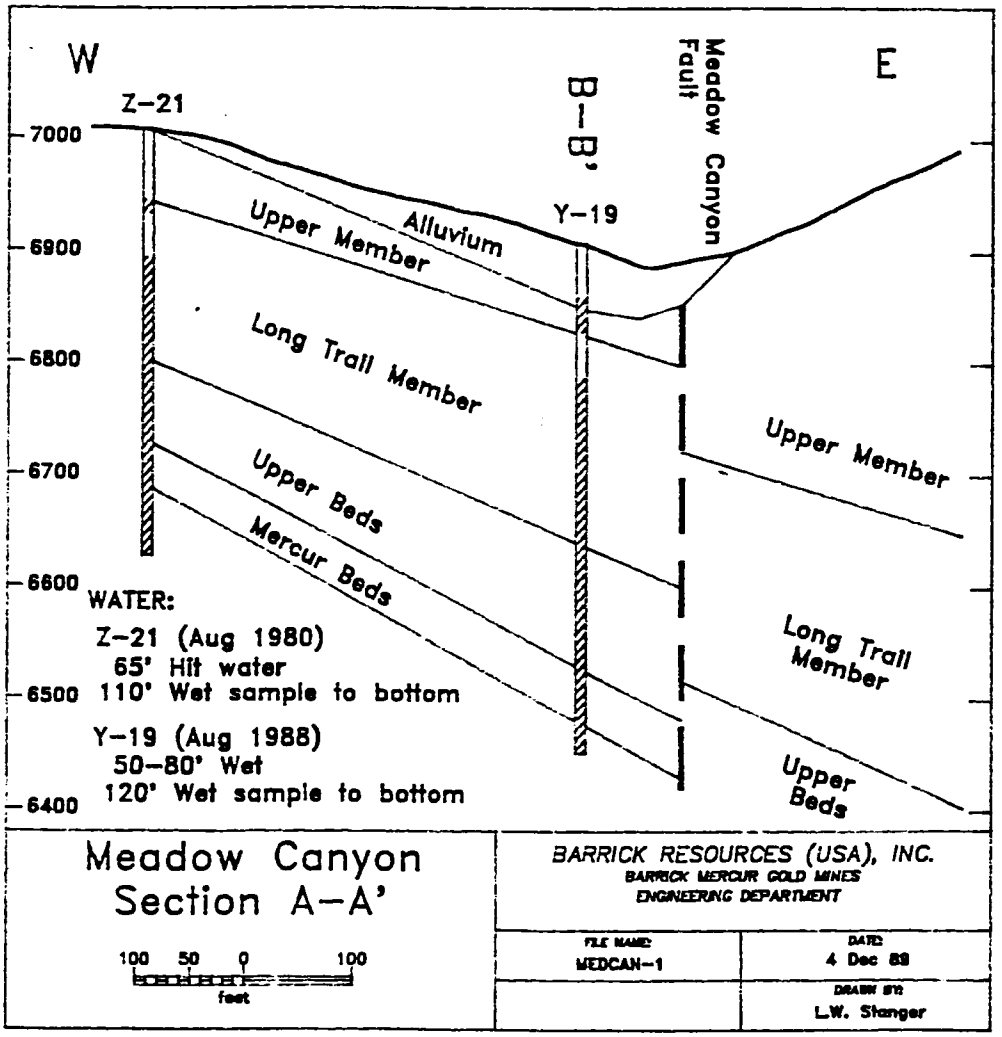
W
E
Z-21
B-B'
Y-19
Meadow Canyon Fault
7000
6900
6800
6700
6600
6500
6400
Alluvium
Upper Member
Long Trail Member
Upper Beds
Mercur Beds
Upper Member
Long Trail Member
Upper Beds
WATER:
Z-21 (Aug 1980)
65' Hit water
110' Wet sample to bottom
Y-19 (Aug 1988)
50-80' Wet
120' Wet sample to bottom
Meadow Canyon
Section A-A'
100 50 0 100
feet
BARRICK RESOURCES (USA), INC.
BARRICK MERCUR GOLD MINES
ENGINEERING DEPARTMENT
FILE NAME:
MEDCAN-1
DATE:
4 Dec 88
DRAWN BY:
L.W. Stanger

Figure 3

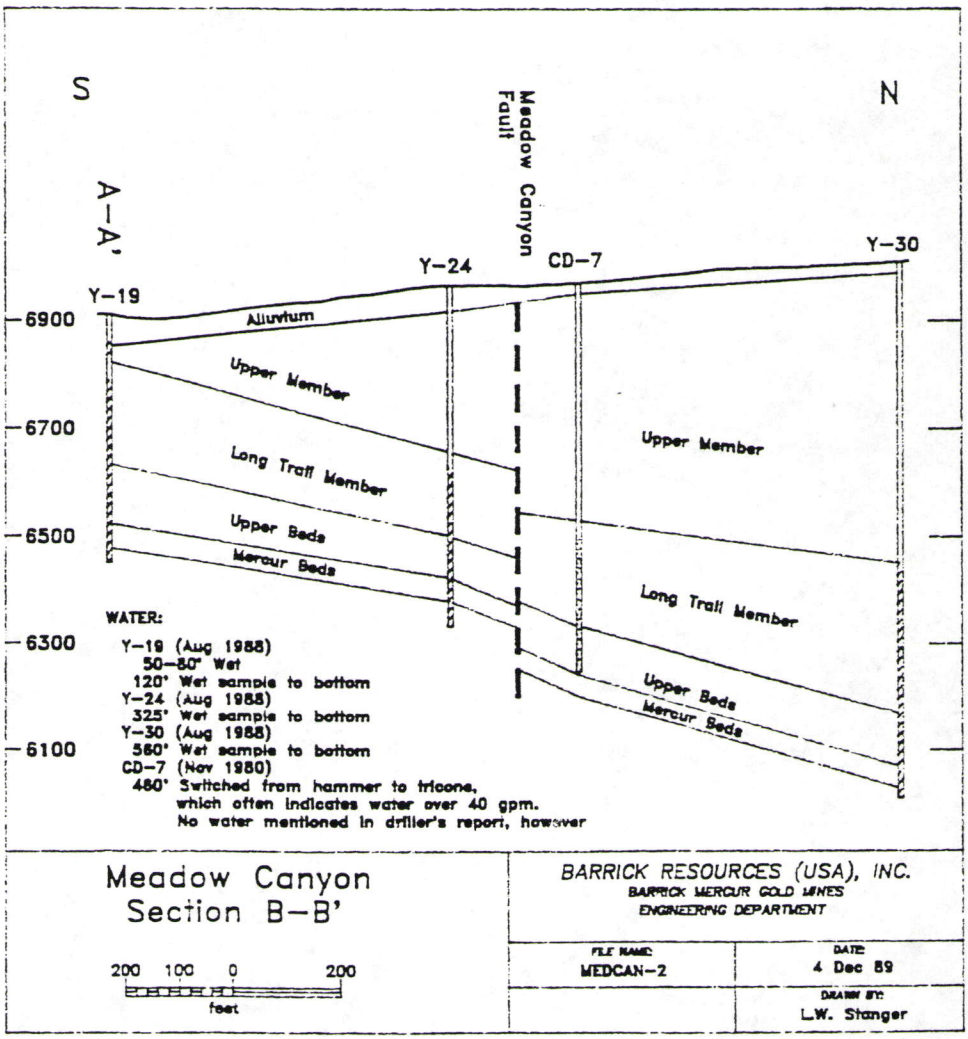
S
N
A–A'
Meadow Canyon Fault
Y–19
Y–24
CD–7
Y–30
6900
6700
6500
6300
6100
Alluvium
Upper Member
Long Trail Member
Upper Beds
Mercur Beds
Upper Member
Long Trail Member
Upper Beds
Mercur Beds
WATER:
Y–19 (Aug 1988)
50–80' Wet
120' Wet sample to bottom
Y–24 (Aug 1988)
325' Wet sample to bottom
Y–30 (Aug 1988)
560' Wet sample to bottom
CD–7 (Nov 1980)
480' Switched from hammer to tricone, which often indicates water over 40 gpm. No water mentioned in driller's report, however
Meadow Canyon
Section B–B'
200 100 0 200
feet
BARRICK RESOURCES (USA), INC.
BARRICK MERCUR GOLD MINES
ENGINEERING DEPARTMENT
FILE NAME:
MEDCAN–2
DATE:
4 Dec 89
DRAWN BY:
L.W. Stanger

Figure 4

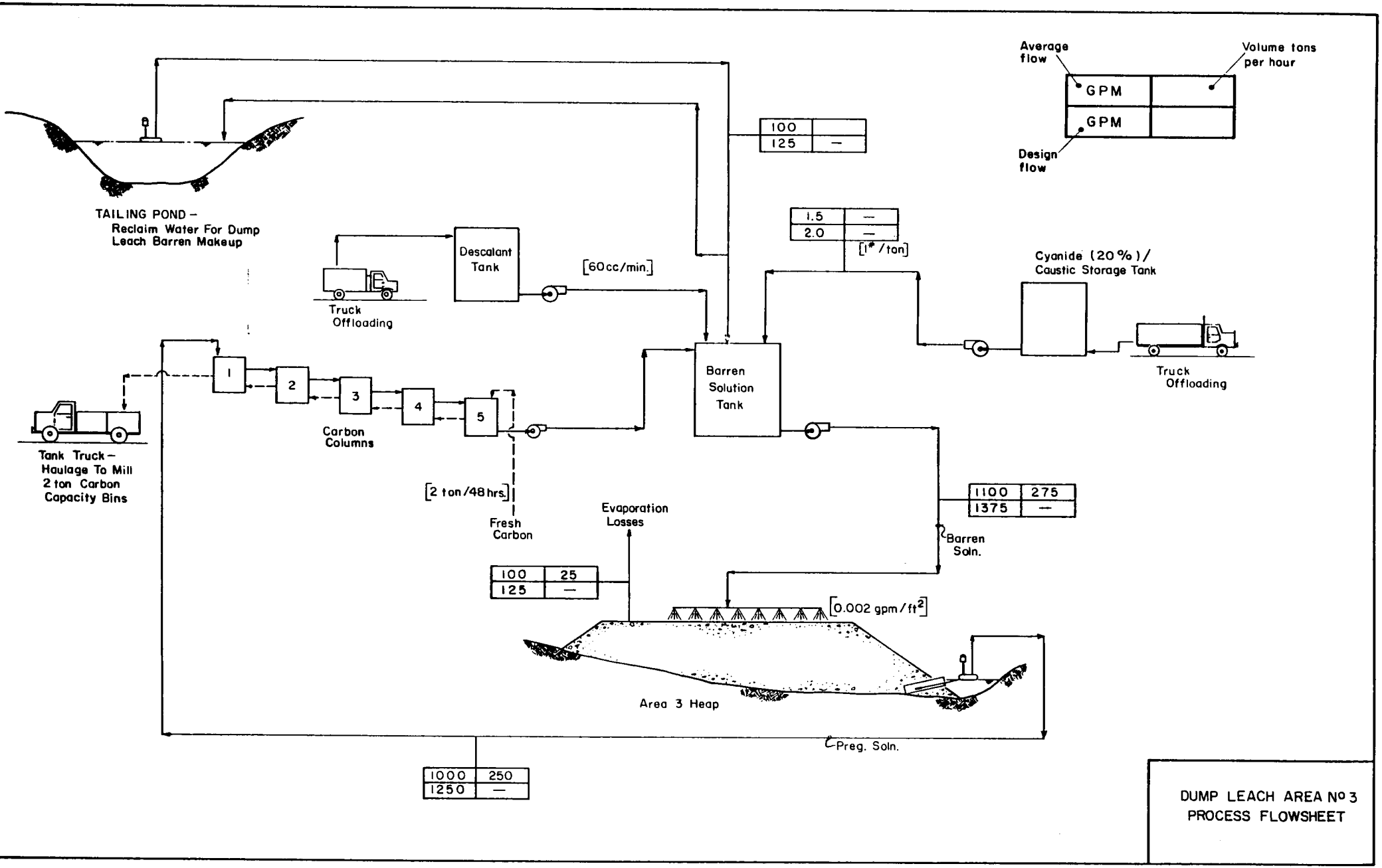
Average flow
Volume tons per hour
GPM
GPM
Design flow
TAILING POND –
Reclaim Water For Dump Leach Barren Makeup
100
125
—
Descalant Tank
[60cc/min.]
Truck Offloading
1.5
2.0
—
—
[l* /ton]
Cyanide (20%) / Caustic Storage Tank
Truck Offloading
Barren Solution Tank
1
2
3
4
5
Carbon Columns
Tank Truck – Haulage To Mill 2 ton Carbon Capacity Bins
[2 ton/48 hrs.]
Fresh Carbon
Evaporation Losses
1100
1375
275
—
Barren Soln.
100
125
25
—
[0.002 gpm/ft²]
Area 3 Heap
Preg. Soln.
1000
1250
250
—
DUMP LEACH AREA No 3
PROCESS FLOWSHEET

Figure 5

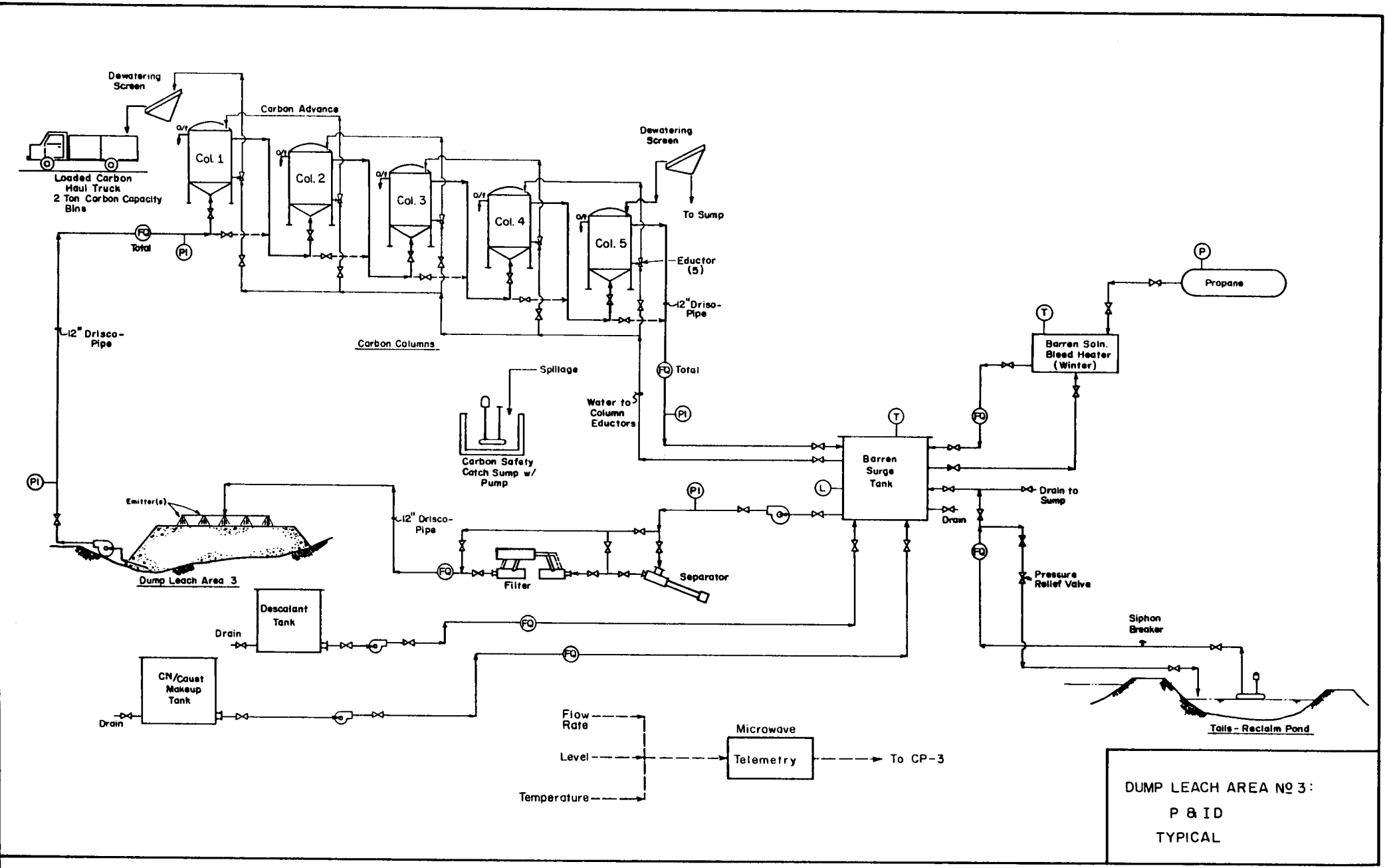
Dewatering Screen
Carbon Advance
Loaded Carbon Haul Truck 2 Ton Carbon Capacity Bins
Col. 1
Col. 2
Col. 3
Col. 4
Col. 5
Dewatering Screen
To Sump
Eductor (5)
12" Driso-Pipe
Total
PI
12" Drisco-Pipe
Carbon Columns
Spillage
Carbon Safety Catch Sump w/ Pump
Water to Column Eductors
Total
PI
Barren Surge Tank
Barren Soln. Bleed Heater (Winter)
Propane
Drain to Sump
Drain
Pressure Relief Valve
Siphon Breaker
Emitter(s)
12" Drisco-Pipe
Dump Leach Area 3
Filter
Separator
Descalant Tank
Drain
CN/Caust Makeup Tank
Drain
Flow Rate
Level
Temperature
Microwave
Telemetry
To CP-3
Tails - Reclaim Pond
DUMP LEACH AREA Nº 3:
P & ID
TYPICAL

Figure 6

Barrick Mercur Gold Mine
Dump Leach 3
Stage I Construction
Embankment Safety Factors

Model	Critical Location	Safety Factor
DL3: Ore Face Slope 1.5:1	Toe	1.86
DL3: Ore Side Slope 1.5:1	Lower Slope	1.87
DL3: Complete Structure	Toe	1.60
DL3: Complete Structure 0.1g Seismic Loading	Toe	1.27
DL2: Complete Structure	Face Ramp Lower Slope	1.64
DL2: Complete Structure 0.1g Seismic Loading	Face Ramp Lower Slope	1.24

Table I.

Barrick Mercur Gold Mine
Dump Leach 3
Subore Quantities

Elevation	Incremental Liner Area (Acres)	Cumulative Liner Area (Acres)	Incremental Tons	Cumulative Tons
7050	1.38	1.38	35,198	35,198
7070	3.88	5.26	163,333	198,531
7090	4.48	9.74	369,040	567,571
7110	3.92	13.66	575,875	1,143,446
7130	3.72	17.38	764,012	1,907,458
7150	3.49	20.87	941,356	2,848,814
7170	N/A	N/A	951,355	3,800,169
7190	"	"	800,622	4,600,791
7210	"	"	658,079	5,258,870
7230	"	"	524,859	5,783,729
7250	"	"	398,135	6,181,864
7270	"	"	281,300	6,463,164
Total		20.87	6,463,164	

Table II.

Barrick Mercur Gold Mine
Dump Leach 3
Foundation Waste Rock Quantities

Elevation	Incremental Liner Area (Acres)	Cumulative Liner Area (Acres)	Incremental Tons	Cumulative Tons
6910	N/A	N/A	3,331	3,331
6930	"	"	102,881	106,212
6950	"	"	161,864	268,076
6970	"	"	239,830	507,906
6990	"	"	330,564	838,470
7010	"	"	430,338	1,268,803
7030	0.05	0.05	545,028	1,813,836
7050	1.33	1.38	648,305	2,462,141
7070	3.88	5.26	685,027	3,147,168
7090	4.48	9.74	664,632	3,811,800
7110	3.92	13.66	582,712	4,394,512
7130	3.72	17.38	426,327	4,820,839
7150	3.49	20.87	295,310	5,116,149
Total		20.87	5,116,149	

Table III.

Barrick Mercur Gold Mine
Dump Leach 3
Potential Liner Clay Sources
Back Pressure Permeability Tests

Permeability Units ($X10^{-7}$cm/sec)

Sample Number	Description	Water Column (ft) 10	30	50
1a	Upper Lady May (Relic Slide-Red)	0.0961	0.0742	0.0421
1b	"	0.0212	0.0312	0.0294
2a	Lady May Slide (Black)	0.0203	0.0359	0.0334
2b	"	0.151	0.124	0.112
3a	7080 Stockpile Screened-Black	0.0509	0.161	0.191
3b	"	0.0226	0.0196	0.0278
4a	Sacramento Shale (Pyritic)	2.40	4.23	4.38
4b	"	0.893	0.945	0.839
5a	Sacramento Shale (Carbonaceous)	1.28	1.22	1.00
5b	"	0.244	0.164	0.218
6	Rush Valley Loam (50 psi)	73.6	23.7	5.76
7a	Foundation-West Slope	0.539	0.396	0.668
7b	"	0.154	0.189	0.168
8a	Foundation-South Slope	0.0669	0.0648	0.0578
8b	"	0.120	0.114	0.168

Note: a, b: Confining Pressure; a = 80 psi, b = 160 psi

Table IV.